South Dakota Water Research Institute
Annual Technical Report
FY 2011

Introduction

2010-2011 Annual Report Introduction and Research Program South Dakota's Water Resources Institute's program is administered through the College of Agricultural and Biological Sciences at South Dakota State University (SDSU). Dr. Van Kelley has been the Director for the Institute since August 1, 2000. Dr. Kelley is also the head of the Agricultural and Biological Engineering Department. In addition, the Institute's programs are administered and executed by a staff consisting of an Assistant Director, a Program Manager, a Program Assistant, an Assistant Professor and a Research Associate.

The annual base grant from the United States Geological Survey (USGS) and a South Dakota legislative appropriation of $98,651 form the core of the SDWRRI budget. The core budget is supplemented by research grants from a state and federal agencies as well as private organizations and industry interested in specific water-related issues.

The mission of the South Dakota Water Resources Institute is to address the current and future water resource needs of people, agriculture, industry and the environment through research, education, and service. To accomplish this mission, SDWRI provides leadership in coordinating the research and training at South Dakota State University and other public educational institutions and agencies across the state in the broad area of water resources. Graduate research training, technology transfer, and information transfer are services which are provided through the Institute. This report is a summary of activities conducted during March 1 2011 through February 28 2012 (termed FY12 in the following) to accomplish this important mission.

Research Program Introduction

2010-2011 Annual Report Research Program

Water is one of the most important resources in South Dakota. Together with the state's largest industry, agriculture, it will play an important role in the economic future of the state. Enhancement of the agricultural industry and allied industries, the industrial base and, therefore, the economy of South Dakota all depend on compatible development of our water resources.

During 2010-2011, the South Dakota Water Resources Institute (SD WRI) used its 104B Grant Program funds to conduct research of local, state, regional, and national importance addressing a variety of water problems in the state and the upper Midwest region.

During October 2010 the Advisory Committee reviewed 6 grant applications and recommended 4 projects for funding that addressed research priorities that had a good chance of success, and would increase our scientific knowledge. The projects were titled

Investigation of the Contribution of Coliform Contamination in Runoff from Scoured Bed Sediments, PI's Jennifer L. Benning, Scott J. Kenner, Arden D. Davis. South Dakota School of Mines and Technology Life Cycle Assessment Analysis of Engineered Stormwater Control Methods Common to South Dakota, PI's Molly Gribb, James Stone and Jennifer Benning. South Dakota School of Mines and Technology Determination of Microbial Kinetics for the Degradation of Estrogens and Triclosan in Activated Sludge Systems. PI Christopher G. Schmit, South Dakota State University Fate and Transport of Biogenic Uraninite in the Environment. PI Rajesh Sani, South Dakota School of Mines and Technology.

These projects were scheduled to begin March 1 2010 but because of delay in funding appropriation from the USGS funds were not released until between May 25 2011 and October 1 2011. Because the delay, relative to March 1 2011, in when the project funds were released to the project investigators, three of the four projects are ongoing. Therefore, only one project completion report is attached with this annual report. The remaining three project reports will be submitted along with next year's annual report.

Fate and Transport of Biogenic Uraninite in the Environment

Basic Information

Title:	Fate and Transport of Biogenic Uraninite in the Environment
Project Number:	2011SD224B
Start Date:	3/1/2011
End Date:	2/29/2012
Funding Source:	104B
Congressional District:	South Dakota 1
Research Category:	Biological Sciences
Focus Category:	Groundwater, Radioactive Substances, Toxic Substances
Descriptors:	
Principal Investigators:	Rajesh Kumar Sani

Publications

There are no publications.

Final Report

Title: Fate and Transport of Biogenic Uraninite in the Environment

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Introduction
U is the most common radionuclide in groundwater, soils, and sediments at many sites, and is therefore of particular concern due to its toxicity and carcinogenicity. In South Dakota, U mining operations have contaminated surface water, sediments and groundwater. For example,

at the Edgemont Mill Site, located in the east of Edgemont, SD, soil, ground water and pit water are contaminated with high U concentrations (Rastogi et al. 2009; Kipp et al. 2009). In addition, U is present at several DOE sites (Anderson et al. 2003). The most common form of U in surface water/river/groundwater is U(VI), which is present either as the uranyl cation (UO_2^{2+}) or as anionic carbonate complexes, $UO_2(CO_3)_2^{2-}$ and $UO_2(CO_3)_3^{4-}$. These oxidized species of U are highly soluble and mobile in groundwater. On the other hand, the common reduced form of U, U(IV), is predominantly insoluble and present in the form of mineral uraninite (UO_2). Thus, the oxidized form U(VI) presents significant health hazards due to its solubility and mobility. Reduction of U(VI) to U(IV) can serve as a remediation strategy. Since sulfate reducing bacteria (SRB) can perform U(VI) reduction both enzymatically and non-enzymatically, stimulating SRB in contaminated zones can be used for U remediation through its immobilization as U(IV).

In addition to U, SRB also have potential to precipitate a variety of other heavy metals contaminants found in the region such as arsenic, copper, chromium, lead and zinc, by forming insoluble metal sulfides or hydroxides. These heavy metals are present all over the South Dakota including Deadwood, Edgemont, Cave Hills, Slim Buttes, Rapid Creek near Rapid City, and Belle Fourche River near Belle Fourche. As can be seen, radionuclides such as U constitute a significant groundwater problem in the South Dakota, and have attracted the attention of many stakeholders in the region. Because of the potential health implications, these metal ions are of concern not only to the EPA, but also to local populations and environmental groups, including several Native American tribes. U could potentially be treated and immobilized with natural indigenous bacteria (e.g., SRB). Hence, it is vital that an understanding of the complex biogeochemical processes that govern the fate and transport of U as well as the stability of immobilized uraninite be developed for sites in the region.

Research Objectives

The main objectives of the research were

i) Batch studies of U reduction with and without iron minerals to quantifying the partitioning of various phases of U.

ii) Identification of Fe/S/U species during U bioreduction to provide solid-phase geochemistry

Methodology

Batch studies of U reduction by SRB with and without iron minerals

A sulfate reducing bacterium (SRB), *Desulfovibrio desulfuricans* G20, was grown in MTM (Metal Toxicity Medium, growth medium developed in our laboratory designed to study microbe-metal interactions -Sani et al. 2001). In order to mimic natural conditions, Fe(III)(hydr)oxide minerals (hematite and ferrihydrite) and quartz (α-SiO_2, 212-300 μm) as model redox-sensitive and -insensitive aquifer minerals, respectively were used. The Fe(III)(hydr)oxides were chosen because they are common soil constituents and capable of adsorbing large quantities of metals. Heat-treated Fe(III) minerals and quartz at a ratio of 1:19 (80 and 1520 mg, respectively) were added to serum bottles containing U(VI) and MTM. Typical redox-sensitive mineral concentrations (e.g., Fe minerals) found in soils range from 0.5 to 6% (w/w) (O'Day et al. 2004), therefore, about 5% (w/w) ferrihydrite or hematite in MTM supplemented with 0 - 180 μM U(VI) were used. Treatments with and without iron minerals revealed the roles of Fe and S minerals in the distribution of bioreduced U phases. Serum bottles were capped with butyl-rubber septa, crimped with aluminum seals, purged and pressurized with

a mixture of N_2 (80%) and CO_2 (20%) at 68.9 kPa (10 psi) above atmospheric pressure. The bottles were incubated at 37°C in a horizontal position on an orbital shaker at 120 rpm. After equilibration of U(VI) and Fe and S minerals, serum bottles were inoculated with *Desulfovibrio desulfuricans* G20 cells. Late-log phase grown *Desulfovibrio desulfuricans* G20 cells were harvested, washed as described previously (Sani et al. 2008), and were used to inoculate serum bottles at about 5 mg/L cell protein. Uranium concentrations were measured by existing Kinetic Phosphorescence Analyzer (KPA).

Size fractionation of the reduced Uraninite

Developing a fundamental, mechanistic understanding of the fate of U in complex systems requires quantifying the partitioning of U in multiple particulate, nanoparticulate and colloidal phases. Size fractions were obtained by passing the samples through membrane filters (0.2 µm membrane filters, 3-kDa (pore size, 1.8 nm), 30-kDa (pore size, 18 nm). Samples of unfiltered, filtered, filtered oxidized, and unfiltered oxidized were analyzed for U (VI) content on the KPA. By oxidizing the samples after filtration and re-running the KPA analysis, the distribution of bioreduced U phases (nanoparticulate and colloidal phases) during reducing conditions were obtained (as described in the Figure 1). These analyses quantified uraninite that is i) cell associated (unfiltered oxidized, A in the supernatant minus total U), ii) in suspension or in aqueous phase or on other colloids e.g., organic compounds/by-products (filtered oxidized, C filtered minus unoxidized, D), aggregate/immobile form (unfiltered oxidized, A minus 0.2 µm filtered oxidized C), and particles <0.6 nm in size (oxidized, E minus unoxidized, F).

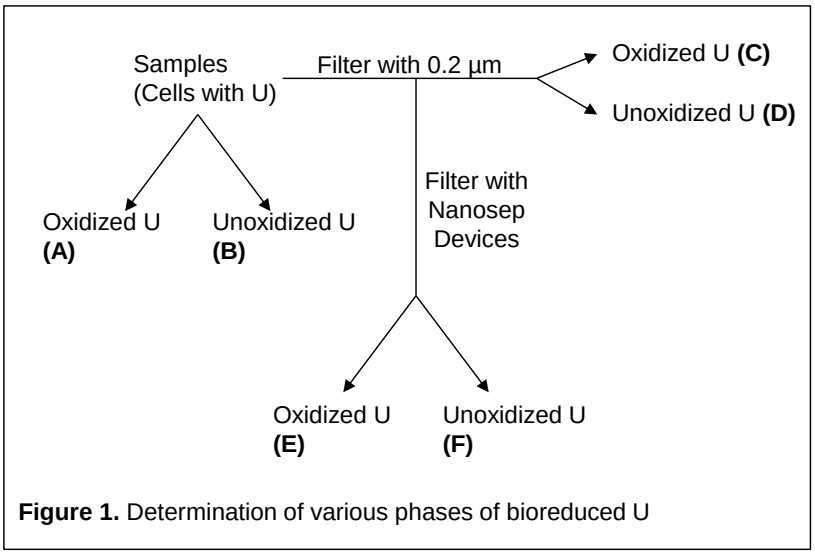

Figure 1. Determination of various phases of bioreduced U

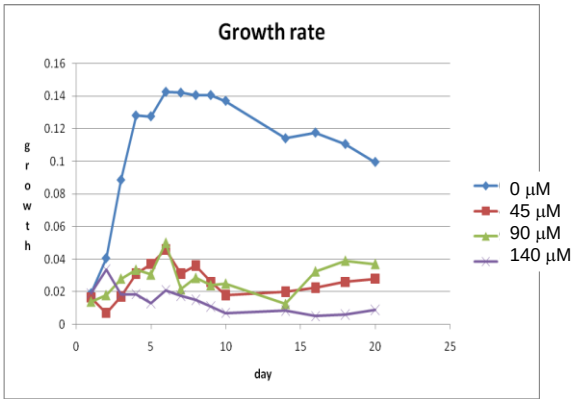

Figure 2. Effect of different concentrations of U on the growth of *Desulfovibrio desulfuricans* G20

Results:

Growth Experiments

The growth rate of the bacterium (G20) on the MTM with 45µM, 90µM, 140µM of Uranium (VI) and without U(VI) were studied and are shown in figure 2. From the results it was clear that U in all the mentioned concentrations inhibited the growth of the G20, while the cultures without U grew with a faster rate. Since the bacterium (G20) was growing with the U at a high concentration of 90 µM (`21 mg/L), it was selected for further experiments.

Reduction and Precipitation Experiments

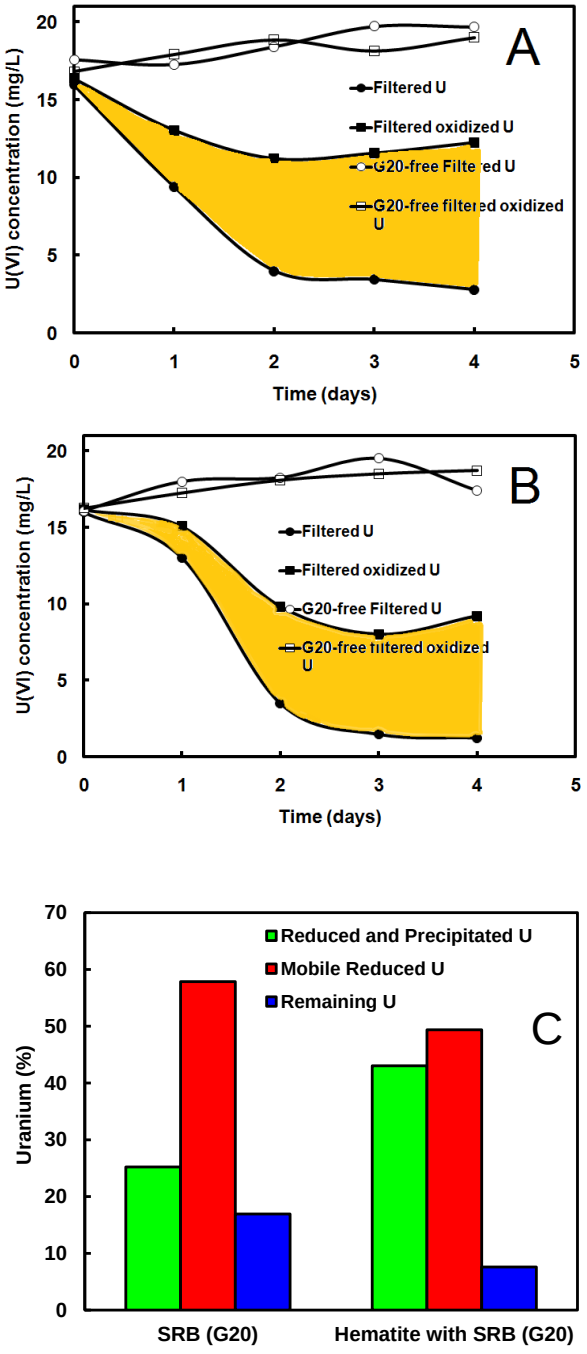

Figure 3. Uranium reduction profiles of G20 with hematite-free control (A) and hematite (B). The highlighted region shows the reduced U in aqueous phase.
Fig C shows the comparative distribution of U in different phases in the presence and absence of hematite.

To accurately determine the fate, transport, and stability of reduced U, batch experiments were performed using our model bacterium, *Desulfovibrio desulfuricans* G20. We characterized bioreduced U in suspension (mobile phase) and precipitates. The influence of soil minerals (hematite and quartz) on the various phases of bioreduced U was also determined. Experiments were performed with *Desulfovibrio desulfuricans* G20 in the presence of 90 µM U(VI). Our results showed that a significant portion of U(VI) was reduced to U(IV) but not precipitated out (i.e. it was found in liquid phase). For example, using SRB (*Desulfovibrio desulfuricans* G20), 82% U was reduced but only 25% U (out of 82%) was precipitated out (Figs 3A and C). The remaining 57% reduced U was in liquid phase and thus mobile. To increase in amount of precipitated U, experiments were performed in the presence of hematite (a common soil mineral). It was found that addition of hematite to the medium increased the reduction and precipitation of the U(VI). It was seen that 92% of U(VI) was reduced in the medium and 45% of that was precipitated out (Figs 3B and C). Still 52% reduced U was in liquid phase (mobile) and was the area of concern (yellow shaded area in Figs 3A and B).

Size fractionation experiment:
There was a huge difference in the filter-oxidized samples that were filtered through 0.2µ filters and nano-filtered samples containing G20 (Table 1). The difference was very negligible, howver, in the filtered unoxidized samples containing G20. These data suggest that the size of the reduced and mobile U(IV) present in the media was greater than

18nm (30kD). Results also suggest that with decreasing the pore size of membrane, filtrate U concentrations were decreasing (Table 1). For example, in the presence of G20, with 30 and 3 KD membranes, the filtrate U concentrations were 16 and 6 mg/L, respectively (Table 1). These data also indicate that reduced U particles sizes also depended on the presence of hematite (Table 1).

Table 1: Size fractionation of various phases of bioreduced U (mg/L) within batch systems

	0.2µ		30kD		10kD		3kD	
	F	FO	F	FO	F	FO	F	FO
U	61.208	60.335	55.491	68.952	64.835	57.87	62.062	63.673
U+G20	10.624	49.9635	9.5625	16.125	8.033	10.3065	4.993	5.9995
Hematite+U	74.52	70.137	74.448	68.316	74.605	65.988	68.59	70.848
Hematite +U+G20	12.0855	53.8175	9.3465	16.076	6.095	5.5465	6.5565	6.3535

In addition to characterization of various U phases, characterization of solid-phase geochemistry of secondary minerals was carried out. For Fe or S secondary minerals formed during U reduction were analyzed using HR-TEM (Figure 4) and Mössbauer spectroscopy (Figure 5). Using Mössbauer spectroscopy, results showed that 20-25% of the hematite was transformed. Hematite-SRB treatments gave a "iron sulfide" product which was very unstable in air (when samples were exposed to air for 1 h - Fe(II) phase was disappeared). Mössbauer data

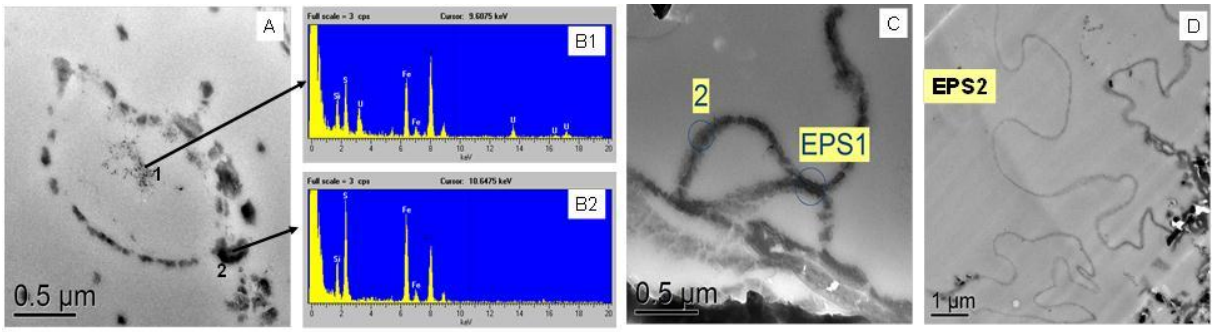

Figure 4. Transmission electron microscopic images of *Desulfovibrio desulfuricans* G20 culture treated with 2 mM U(VI) in metal toxicity medium in the presence of hematite. Heavy precipitation of biogenic uraninite and sulfides was observed within the periplasm and cytoplasm (A). Apparent precipitates of uraninite/sulfide inside the cell (#1 in A) and associated with the cell surfaces (#2 in A) were confirmed by energy-dispersive X-ray spectroscopy (B1 and B2). TEM and EDS also show that this G20 produces extracellular polymeric substances where uraninite is trapped outside the cell (C and D). Copper background signals in B1 and B2 originate from the Cu grid.

suggested that all the iron sulfide products were completely oxidized and produced lepidocrocite. Mössbauer data showed that these iron sulfide products were not mackinawite, siderite, or pyrite. Interestingly Mössbauer data of the sample and its temperature behavior suggested that the precipitates could be of greigite.

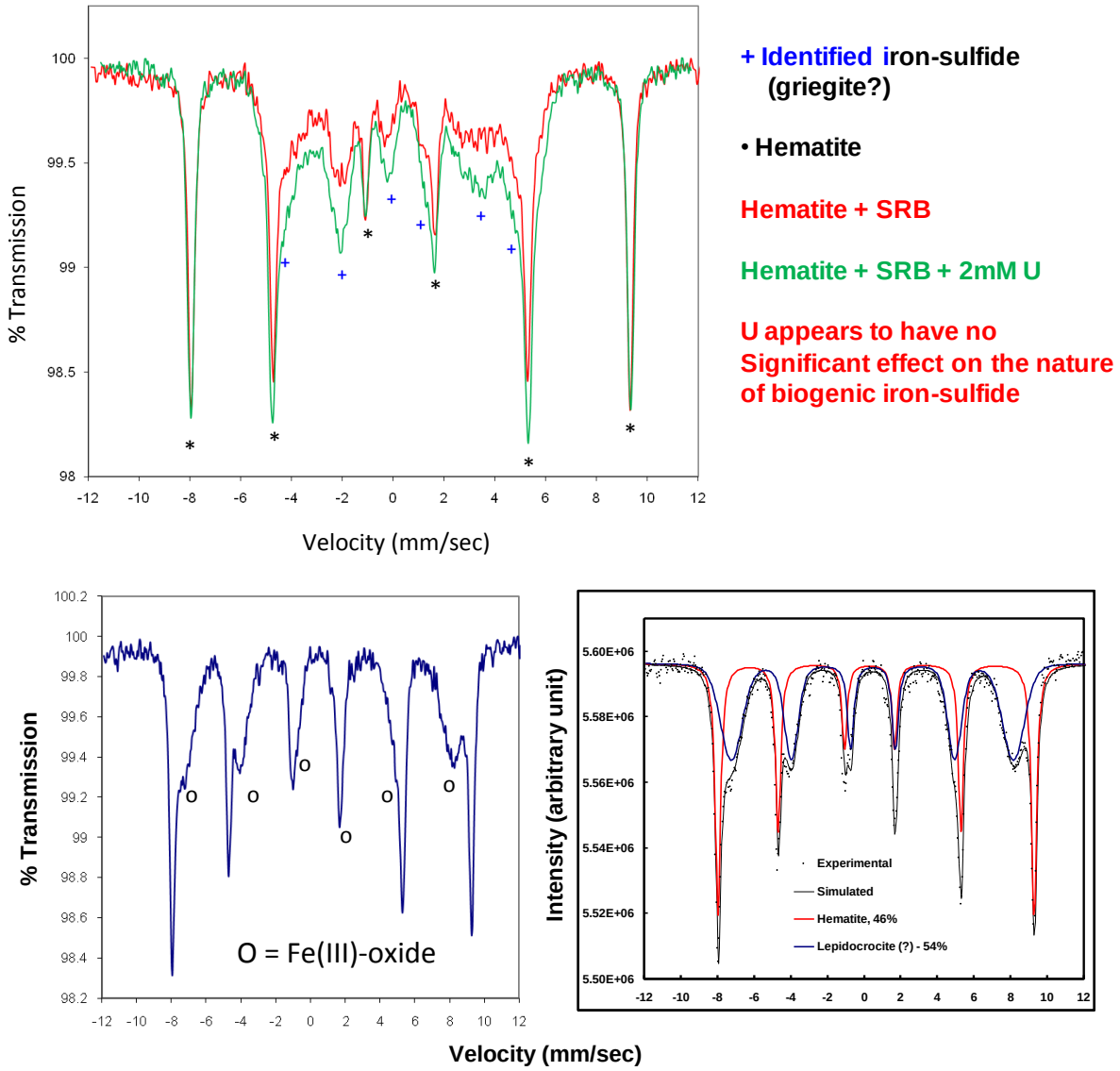

Figure 5: Mossbauer spectra of samples without U. Peak fitting indicates that iron-sulfide is oxidized to lepidocrocite. Studies are in progress to determine the nature of iron-sulfide.

Summary and conclusions

Results showed that in the presence of soil minerals (e.g., hematite, quartz), more U was reduced and precipitated. In the presence of hematite, more U precipitated in comparison to the experiments in which hematite was absent. Most of the reduced and mobile uraninite particles were nanometer sized, though a large fraction of reduced U was more than 30nm. In addition, reduced uraninite was not only detected in the periplasm of the G20 but also in the cytoplasm and coexistence of uraninite and iron sulfides were detected inside the cell. TEM and EDS also show that this G20 produces extracellular polymeric substances where uraninite was trapped outside the cell. Mössbauer showed various forms of iron sulfides (most of the amorphous).

Mössbauer data also indicated the presence of greigite. Further research is needed to identify the iron sulfide products.

Student Support

Mr. Rajneesh Jaswal (Graduate student, Chemical and Biological Engineering) worked on the project and presented a poster related to this work in the AICHE Annual meeting 2011, and was awarded 3rd place in the competition. Mr. Rajneesh is currently working further in this project and troubleshooting the problems. In addition, two female undergraduate students (Emily Squillace and Anne Winckel) were trained by this project.

Poster Presentations:

Rajneesh Jaswal, Sudhir Kumar, Emily Squillace, Gursharan Singh, Ravi Kukkadapu, Alice Dohnalkova, Brent Peyton, Nicolas Spycher, Timothy Ginn, and Rajesh Sani. 2011. Bioreduced uranium transport potential under sulfate reducing conditions: Effects of Fe(III)(hydr)oxides. In: Society for Industrial Microbiology Annual Meeting and Exibition at New Orleans, LA, USA. July 24-29, 2011.

Rajneesh Jaswal, Sudhir Kumar, Gursharan Singh, Emily Squillace, Ravi Kukkadapu, Alice Dohnalkova, Brent Peyton, Nicolas Spycher, Timothy R Ginn, and Rajesh Sani. 2011. Effects of Fe(III)(hydr)Oxides On Transport of Bioreduced Uranium Under Sulfate Reducing Conditions. In: AICHE 2011 Annual Student Conference at Minneapolis, MN, USA. Oct 14-17, 2011. This presentation ***Won 3rd position in the Environmental Division Poster Presentation***

Invited presentation

Rajesh Sani, Rajneesh Jaswal, Sudhir Kumar, S. Sevinç Şengör, Ravi Kukkadapu, Alice Dohnalkova, Brent M. Peyton, Nicolas Spycher, and Timothy R Ginn. Fate, transport, and stability of biogenic uraninite: its interactions with microbes and soil minerals. International workshop on uranium biogeochemistry: transformations and applications March 2012 in Ascona, Switzerland.

Manuscripts:

Under Review

Singh G, Şengör SS, De J, Stewart B, **Bhalla A**, Kumar S, Spycher N, Ginn TM, Peyton BM, Sani RK. 2012. Reoxidation of Reduced Uranium: A Review of Current Trends to Elucidate the Mechanisms. ***Critical Reviews in Environmental Science and Technology***

Under Preparation

Rajesh Sani, Gursharan Singh, Sudhir Kumar, S. Sevinç Şengör, Ravi Kukkadapu, Alice Dohnalkova, Brent M. Peyton, Nicolas Spycher, and Timothy R Ginn. 2012. Bioreduced uranium transport potential under sulfate reducing conditions: Effects of Fe(III) (hydr)oxides.

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Information Transfer Program Introduction

The Information Transfer Program includes public outreach, interpretation of laboratory analysis results, active participation in the annual Dakotafest farm show, steering committee representation and leading involvement in the Big Sioux Water Festival and in The Eastern South Dakota Water Conference, interactions with extension agents and local, state and federal agencies, participation and presentations at regional and national conferences, youth education, adult education and university student training and education. Publications, such as pamphlets, educational materials, reports and peer-reviewed journal entries are made available in paper format and electronic through the Institute's website and are designed to support the mission of the Institute.

Public Outreach Public outreach and dissemination of research results are cornerstones of the South Dakota Water Resources Institute's (SD WRI) Information Transfer Program. Information Transfer takes many forms, including interactive information via the Internet, pamphlets and reports, direct personal communication, hands-on demonstrations and through presentations and discussions at meetings, symposia and conferences are used to ensure effective transfer of water resources information to meet the needs different audiences.

Water News Newsletter The South Dakota Water Resources Institute Water News quarterly newsletter is in its eighth year of publication. The newsletter underwent a redesign over the summer of 2011 with the first edition of the redesigned newsletter was released in August 2011 and is included in Appendix A. The newsletter is an effective media to disseminate information about activities in which the Institute participates, funds, and promotes. The newsletter is distributed via e-mail, as well as a link on the SD WRI homepage (http://sdstate.edu/abe/wri) in PDF format allowing for viewing of past and present issues. The website additionally has a subscription request form to sign up to receive the newsletter. Water-related research including updates on present projects, notification of requests for proposals, state-wide water conditions, conferences, as well as information on youth activities are highlights in each issue.

SD WRI Website During the past year, substantial efforts went into updating and redesigning the SD WRI website located accessible through http://www.sdstate.edu/abe/wri/. The website has been updated to contain information relating to water resources, current and past research projects and reference material and extension publications. Since redesigning the website, the Institute has actively used the website as the entry portal relaying information relating to the Institute and water topics. As a result, the traffic to the website experienced a substantial increase over the year.

SD WRI's web site has been designed to allow users access to updated links which include publications intended to help diagnose and treat many water quality problems. The site allows the public to stay informed about the activities of the Institute, gather information on specific water quality problems, learn about recent research results and links with other water resource related information available on the Web. The "Research Projects" section of the SD WRI web contains past and present research projects, highlighting the Institute's commitment to improving water quality. Excerpts from the website is shown in Appendix B. An extensive library of information relating to water quality has been developed and continues to be updated on-line.

Water quality analysis interpretation Another important component of the Institute's Information Transfer Program is the Water Quality Laboratory (WQL) activities. The lab was consolidated with the Oscar E. Olson Biochemistry Labs in 2004 which in turn formed the private company South Dakota Agricultural Laboratories in 2011. The WQL provides important testing services to water users across the state. Water Resources Institute staff continues to provide interpretation of analysis and recommendations for use of water samples submitted for analysis. Assistance to individual water users in identifying and solving water quality problems is a priority of the Institute's Information Transfer Program. Interpretation of analysis and recommendations

for suitability of use is produced for water samples submitted for livestock suitability, irrigation, lawn and garden, household, farmstead, heat pump, rural runoff, fish culture, and land application of waste. Printed publications and on-line information addressing specific water quality problems are relayed to lab customers to facilitate public awareness and promote education.

SD WRI staff also routinely responded to water resource questions unrelated to laboratory analysis from the general public, other state agencies, livestock producers, and County Extension Agents. These inquiries include water quality and quantity, stream monitoring, surface water/ground water interactions, livestock poisoning by algae, lake protection and management, fish kills, soil-water compatibility, irrigation and drainage. SD WRI continues to provide soil and water compatibility recommendations for irrigation permits to the SD Division of Water Rights.

Eastern South Dakota Water Conference SD WRI staff chaired the sixth annual Eastern South Dakota Water Conference held on October 13, 2011 to provide a forum for water professionals to interact and share ideas. The theme of the 2011 conference was Water Management in Extreme Conditions. Sessions throughout the conference offered information important to a wide array of stakeholders including engineers, industry, public officials, agricultural producers, and conservation groups. Water is an important piece of the economic future of South Dakota, and this conference served as a mechanism to educate participants on this resource. Speakers highlighted to importance of the scientific method to determine the state of our water resources. The Eastern South Dakota Water Conference was started in 2006 to serve as a mechanism to educate participants on water resource issues in South Dakota.

The goal of the 2011 Eastern South Dakota Water Conference was to bring together federal, state, and local governments, along with university and citizen insights. The event, in its fifth year, and included speakers and presenters from South Dakota State University (SDSU), South Dakota School of Mines and Technology, The Day Conservation District, South Dakota Department of Water and Natural Resources, North Dakota State University and many others. In addition to the conference, a poster competition for college students was held. Twelve student posters were presented. First prize of $200 went to Nathan Brandenburg from the Water Resources Institute at SDSU and a $100 second prize awarded to Adam Mathiowetz from the SDSU Department of Agricultural Engineering.

Mike Wireman, National Groundwater Expert from the US Environmental Protection Agency in Denver, CO opened the conference with a plenary presentation addressing nitrate contamination in eastern South Dakota. Information about the conference is available at http://www.sdstate.edu/abe/wri/activities/ESDWC/past-con/2011.cfm.

Student Poster Competition Poster Author(s) Poster Title

Jessica Luke, Benjamin Curnow, Bruce Bleakley, Todd Trooien Fecal Coliform Monitoring At Sites Associated With Cattle Feedlots Having Vegetated Treatment Areas in Miner County and Minnehaha County, SD in 2011 Nathan Brandenburg, Jeppe Kjaersgaard, Ron Gelderman, Todd Trooien Developing BMPs to Minimize the Water Quality Impacts of Winter Manure Spreading Melissa Floren, Kyle Hubert, Tim Cowman Impact of Terrain and Land Use on Pesticide and Nutrient Concentrations in Wetlands along the Missouri River

Rajneesh Jaswal, Emily Squillace, Sudhir Kumar, Ravi Kukkadapu, Alice Dohnalkova, Brent M. Peyton, Nicolas Spycher, Timothy R Ginn, Rajesh Sani Fate, transport, and stability of biogenic uraninite: its interactions with microbes and soil minerals Arjun Kafle, Nels H. Troelstrup, Jacob Krause, Katie Bertrand Patterns of abundance and diversity of Ephemeroptera, Plecoptera and Trichoptera from reference and study streams of the Northern Glaciated Plains

Christian Karels Soil Water Content and Evapotranspiration of Corn and Switchgrass

Jeppe Kjaersgaard,Richard Allen, Ricardo Trezza Mapping Evapotranspiration for Water Resources Management Lyntausha Kuehl, Nels H. Troelstrup Features of a database software application and its application to manage reference collections of aquatic biota

Matt J. Lay The Effect of Increased Streamflow on Channel Dynamics of the Lower Big Sioux River (1938-2008)

Adam Mathiowetz Vegetated Treatment System Performance for Beef Confined Animal Feeding Operations Kathleen M. Neitzert, George L. Honeywell, Ryan F. Thompson

Monitoring Bank Erosion on the Missouri River on the Lower Brule Reservation Matt Schwarz, Tom Tornow, Bryan Schultz, Lyman Paul

An Evaluation of Agricultural Tile Drainage Exposure and Effects to Trust Resources within Madison Wetland Management

Eric Stearns Landscape Irrigation Using ET Based Controllers

Pravara Thanapura Mapping Impervious Area and Open Space Using Medium and High Spatial Satellite Imagery for Runoff Index Estimation, Las Vegas, NV

Ryan F. Thompson, James J. Sanovia, Calvin J. Cutschall, George L. Honeywell, Charles J. Tinant Monitoring Bank Erosion on the Missouri River on the Lower Brule Reservation with Ground-based Light Detection and Ranging (LiDAR)

Agency Interactions The SD WRI Information Transfer program includes interaction with local, state, and federal agencies/entities in the discussion of water-related problems in South Dakota and the development of the processes necessary to solve these problems. One of the most productive agency interactions is with the state Non-Point Source (NPS) Task Force, where the SD WRI is represented as a non-core member. The NPS Task Force is administered by the SD Department of Environment and Natural Resources who coordinates, recommends, and funds research and information projects relating to non-point water pollution sources. Participation on the NPS Task Force allows SD WRI input on non-point source projects funded through the task force and has provided support for research in several key areas such as soil nutrient management, agricultural water management, biomonitoring, and lake research. Many of the information transfer efforts of the Institute are cooperative efforts with the other state-wide and regional entities that serve on the Task Force.

Another important interaction is with the South Dakota Department of Environmental and Natural Resources (DENR). Completion of Total Maximum Daily Load (TMDL) studies on South Dakota lakes has been a priority for DENR over the past several years. SD WRI is providing technical assistance to local sponsors working with DENR to complete the TMDL water quality assessments on several publicly owned lakes that do not have an established lakeside community.

SD WRI personnel additionally served on several technical committees and boards, including The Central Big Sioux Master Plan Technical Review Committee, overseeing the monitoring and implementation of the Central Big Sioux water quality master plan for the city of Sioux Falls, Member of the steering committee of the EPA Region 8 Northern Plains and Mountains Regional Water Program, South Dakota NRCS Technical Committee, and Member of the steering committee for the 2012 NIFA National Water Conference

Several other local, state and federal agencies conduct cooperative research with SD WRI or contribute funding for research. Feedback to these agencies is often given in the form of reports and presentations at state meetings, service through committees and local boards, and public informational meetings for non-point source and research projects.

Youth Education Non-point source pollution contributes to the loss of beneficial uses in many impaired water bodies in South Dakota. An important part of reducing non-point pollution is modifying the behavior of people living in watersheds through education. Programs designed to educate youth about how their activities affect water is important because attitudes regarding pollution and the human activities that cause it are formed early in life. For these reasons, Youth Education is an important component of SD WRI's Information Transfer Program.

Water Festivals provide an opportunity for fourth grade students to learn about water. Since they began in 1992 Water Festivals have been held in seven sites including Spearfish, Rapid City, Pierre, Huron, Vermillion, Brookings and Sioux Falls. SD WRI staff members continued to support and participate in Water Festivals throughout the state in FY2012. SD WRI personnel were part of the organizing committee for the 2011 Big Sioux Water Festival held on May 10 2011 where 1033 fourth grade students participated from eastern South Dakota. SD WRI was responsible for coordination of volunteers and helpers, and co-coordinating the exhibit hall. SD WRI also supported water quality education in local schools including classroom presentations and assisting local educators with field trips.

Adult Education David German (SD WRI), Dennis Skadsen (Day Conservation District), Dennis Todey (State Climatologist), and Chris Hay (ABE) presented a lake water quality workshop at Outlaw Ranch near Custer, SD and at Enemy Swim Lake. The workshops were made possible with funds through an EPA 319 grant. The idea behind the workshops stemmed from the fact that most water quality events like Water Festivals are usually targeted towards children.

Another reason for doing the workshops was the idea of "teaching the teachers." Helping adults learn about water quality and providing them with useful information encourages them to teach others in their home community how their behaviors affect the lake. A PowerPoint presentation and sampling equipment assembled at the workshop was available for participants to take home to help encourage them to share what they learned at the workshop. Both workshops offered participants the opportunity to earn continuing education credits and one graduate credit in the education department at SDSU.

Several hands-on activities were developed that helped workshop participants share their new-found knowledge of lakes. These activities included "The Lake Game" and demonstrations of lake stratification, photosynthesis and aquatic plants, as well as biomagnification using "mercury cookies." The group also made their own Secchi discs to monitor the transparency of the lakes they live on. This allows participants to monitor the water quality of a lake and provides an avenue for individuals to take an active part in monitoring their lake.

As part of SDWRI's outreach to the agricultural community, staff hosted a booth at Farmfest and at DakotaFest, each a three-day agricultural fair held in August each year near Redwood Falls, MN and Mitchell, SD, which each draws approximately 30,000 people. A selection of literature an displays regarding water quality is available for distribution and SD WRI staff members field a variety of questions concerning water quality and current research for farm and ranch families. SD WRI staff also hosted a booth at the AgPhD field day held on July 29 near Baltic, SD and the Conservation Connection day held at Bramble Park Zoo in Watertown, SD.

SD WRI personnel participated in and presented at several regional and national meetings and conferences, including the Western SD Hydrology Conference, held April 28 2011 UCOWR/NIWR National Conference

held in Boulder, CO July 11-14 2011, and the Eastern South Dakota Water Conference held October 13 2011. WRI staff published 4 peer reviewed journal articles 12 conference abstracts 2 reports 1 SDSU extension publication In addition, SD WRI staff attracted external funds supporting research projects totaling $410,000 as project PIs or Co-PIs.

USGS Summer Intern Program

Basic Information

Start Date:	1/1/2011
End Date:	1/1/2011
Sponsor:	
Mentors:	
Students:	

Internship Evaluation

Question	Score
Utilization of your knowledge and experience	Acceptable
Technical interaction with USGS scientists	Acceptable
Treatment by USGS as member of a team	Acceptable
Exposure and access to scientific equipment	Acceptable
Learning Experience	Acceptable
Travel	About Right
Field Experience Provided	About Right
Overall Rating	A

Additional Remarks

Basic Information

Start Date:	1/1/2011
End Date:	1/1/2011
Sponsor:	
Mentors:	
Students:	

Internship Evaluation

Question	Score
Utilization of your knowledge and experience	Acceptable
Technical interaction with USGS scientists	Acceptable
Treatment by USGS as member of a team	Acceptable
Exposure and access to scientific equipment	Acceptable
Learning Experience	Acceptable
Travel	About Right
Field Experience Provided	About Right
Overall Rating	A

Additional Remarks

Basic Information

Start Date:	1/1/2011
End Date:	1/1/2011
Sponsor:	
Mentors:	
Students:	

Internship Evaluation

Question	Score
Utilization of your knowledge and experience	Acceptable
Technical interaction with USGS scientists	Acceptable
Treatment by USGS as member of a team	Acceptable
Exposure and access to scientific equipment	Acceptable
Learning Experience	Acceptable
Travel	About Right
Field Experience Provided	About Right
Overall Rating	A

Additional Remarks

Not appicable

Basic Information

Start Date:	1/1/2011
End Date:	1/1/2011
Sponsor:	
Mentors:	
Students:	Not Appicable

Internship Evaluation

Question	Score
Utilization of your knowledge and experience	Acceptable
Technical interaction with USGS scientists	Acceptable
Treatment by USGS as member of a team	Acceptable
Exposure and access to scientific equipment	Acceptable
Learning Experience	Acceptable
Travel	About Right
Field Experience Provided	About Right
Overall Rating	A

Additional Remarks

Not Appicable

Notable Awards and Achievements